Ohio Agricultural Experiment Station.

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PLANS AND SUMMARY TABLES

OF THE EXPERIMENTS AT THE CENTRAL FARM, WOOSTER,

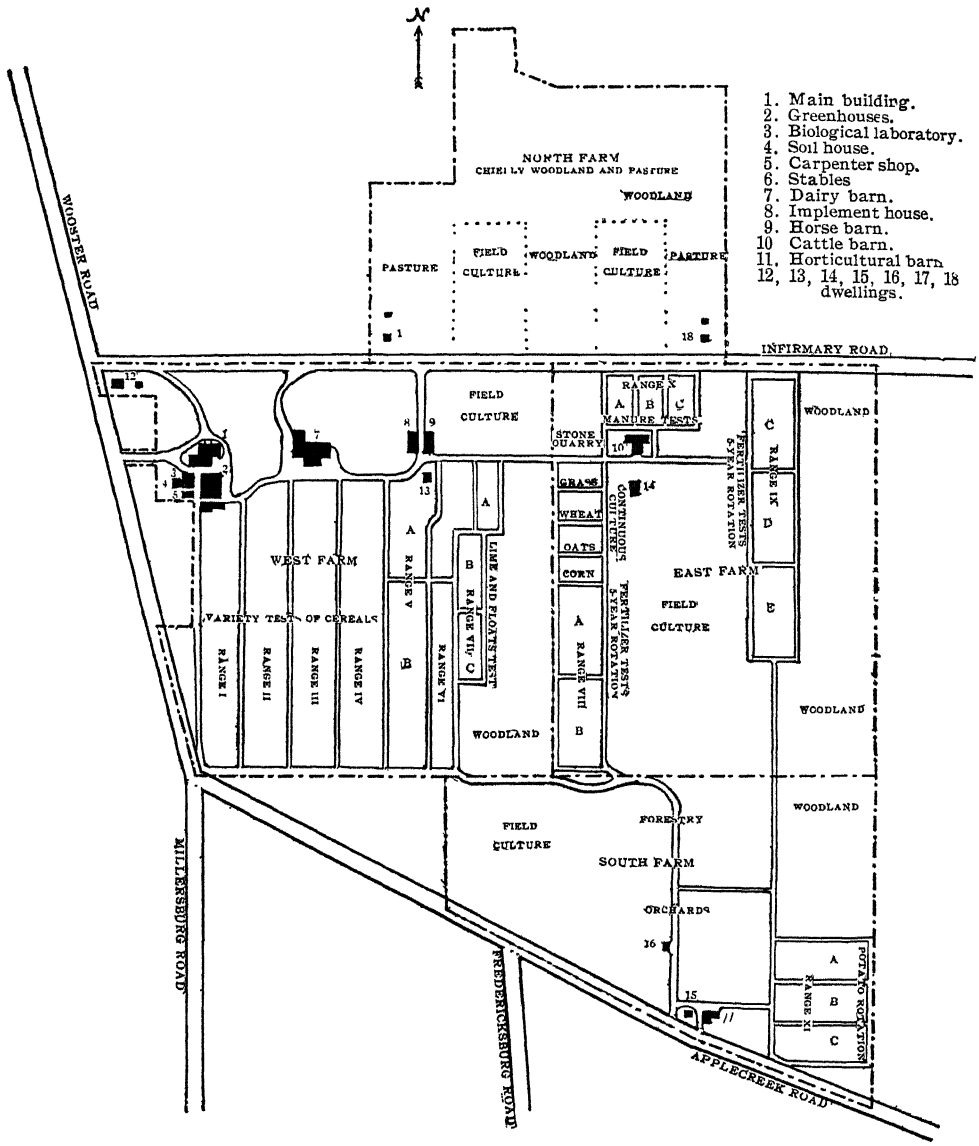
ON THE

MAINTENANCE OF SOIL FERTILITY

ARRANGED FOR REFERENCE IN THE FIELD.

ANNOUNCEMENT.

The experiments reported in the following pages were begun in 1893, immediately after the removal of the Experiment Station to Wayne county. The general plan of this work and the results obtained up to that time are published in Bulletin 110, issued in December, 1899, (now out of print) and again in Bulletins 182, 183 and 184, reporting to the end of 1906. It now seems desirable to follow these general publications with a brief annual statement, giving as briefly as possible the new data obtained from each successive crop, and referring the reader to Bulletins 182 and 183 for more complete information respecting the nature of the soils under experiment and the general plan of the work.



The central farm, near Wooster.

FERTILIZERS AND MANURE ON CROPS GROWN CONTINUOUSLY ON THE SAME LAND.

Wheat, oats and corn, one acre (10 plots) each, have been grown in this experiment since 1894. The fertilizers are applied to Plots 2 and 8 in arbitrary quantities, while on Plots 3 and 9 the three fertilizing elements, nitrogen, phosphorus and potassium, are given in approximately the same ratio to each other in which they are found in the plant.

The applications to Plots 2 and 8 have in every case produced larger yields than those to Plots 3 and 9, but this may in part be accounted for by the combined nitrogen which is carried to the soil in rain, thus enabling the crops grown on 2 and 8 to utilize larger quantities of the phosphorus and potassium given in the fertilizer than merely that required to balance the fertilizer nitrogen.

The manure applications on plots 5 and 6 were intended to carry nitrogen in quantities equivalent to the applications on Plots 2 and 3 on the one hand and 8 and 9 on the other, estimating the manure to carry 10 pounds of nitrogen per ton, but actual analyses of manure, made during recent years, indicate that this estimate was too high for open yard manure, such as is used in these tests. The average application of phosphorus and potassium in the manure closely approximates the average given to the four fertilized plots.

In this test the corn and wheat show a rapid falling off in yield on the unfertilized land during recent years. The oats also show a reduction in yield, but not so great as that of the other crops.

It is much more difficult to control the weed growth in the wheat and oats grown continuously than where the same crops are grown in rotation, and it has been necessary to divide these tracts and fallow the two ends in alternate seasons in order to destroy the weeds.

Diagram I shows the arrangement of plots and plan of fertilizing in this experiment, and the general outcome is shown in Table I, which gives the yields by periods.

DIAGRAM I: PLAN OF FERTILIZING IN CONTINUOUS CULTURE

PLOTS ONE-TENTH ACRE

		Fertilizing materials in pounds per acre
Wheat	1	None
	2	Acid phos., 160; muriate potash, 100; nitrate soda, 120; dried blood, 50*
	3	Acid phos., 45; muriate potash, 30; nitrate soda, 120; dried blood, 50*
	4	None
	5	Yard manure, 2½ tons
	6	Yard manure, 5 tons
	7	None
	8	Acid phos., 160; muriate potash, 100; nitrate of soda, 280; dried blood, 50**
	9	Acid phos., 90; muriate potash, 60; nitrate of soda, 280; dried blood, 50**
	10	None
Oats	1	None
	2	Acid phos., 160; muriate potash, 100; nitrate soda, 160
	3	Acid phos., 55; muriate potash, 50; nitrate soda, 160
	4	None
	5	Yard manure, 2½ tons
	6	Yard manure, 5 tons
	7	None
	8	Acid phos., 160; muriate potash, 100; nitrate soda, 320
	9	Acid phos., 110; muriate potash, 100; nitrate soda, 320
	10	None
Corn	1	None
	2	Acid phos., 160; muriate potash, 100; nitrate soda, 160
	3	Acid phos., 60; muriate potash, 30; nitrate soda, 160
	4	None
	5	Yard manure, 2½ tons
	6	Yard manure, 5 tons
	7	None
	8	Acid phos., 160; muriate potash, 100; nitrate soda, 320
	9	Acid phos., 120; muriate potash, 60; nitrate soda, 320
	10	None
		(South)

*120 pounds nitrate of soda plus 50 pounds dried blood is equivalent to 160 pounds nitrate of soda.
**280 pounds nitrate of soda plus 50 pounds dried blood is equivalent to 320 pounds nitrate of soda.

TABLE I: YIELD AND INCREASE PER ACRE OF CROPS GROWN IN CONTINUOUS CULTURE.

Plot No.	Fertilizing materials. Pounds per acre.	1908 Yield Grain Bus.	1908 Yield Stover or straw Lbs	1908 Increase Grain Bus.	1908 Increase Stover or straw Lbs.	15 years, 1894-1908. Yield Grain Bus.	15 years, 1894-1908. Yield Stover or straw Lbs.	15 years, 1894-1908. Increase Grain Bus.	15 years, 1894-1908. Increase Stover or straw Lbs.	Plot No.
	Corn									
1	None	16.89	1,330	.....	.....	22.71	1,410	.....	.....	1
2	Acid phosphate, 160; muriate potash, 100; nitrate soda, 160	37.54	2,060	23.47	830	43.44	2,266	22.21	915	2
3	" " 60; " " 30; " " 160	18.39	1,930	7.14	800	35.32	1,909	15.57	616	3
4	None	8.43	1,030	.....	.....	18.26	1,235	.....	.....	4
5	Yard manure, 2½ tons	20.11	1,620	12.28	573	29.81	1,739	12.06	516	5
6	" " 5 "	30.07	1,950	22.83	887	39.29	2,089	22.05	879	6
7	None	6.64	1,080	.....	.....	16.71	1,199	.....	.....	7
8	Acid phosphate, 160; muriate potash, 100; nitrate soda, 320	38.21	2,190	32.80	1,187	47.18	2,317	31.50	1,174	8
9	" " 120; " " 60; " " 320	33.39	2,020	29.20	1,093	44.88	2,187	30.25	1,098	9
10	None	2.96	850	.....	.....	13.58	1,033	.....	.....	10
	Average unfertilized yield	8.73	1 072	.. ..	.....	18.27	1 238	.....	.....	
	Oats									
1	None	17.11	702	.....	.....	21.34	775	.....	.....	1
2	Acid phosphate, 160; muriate potash, 100; nitrate soda, 160	41.24	2,150	23.88	1,467	42.60	1,845	20.58	1,037	2
3	" " 55; " " 50; " " 160	39.21	1,895	21.60	1,231	38.67	1,608	15.97	770	3
4	None	17.86	645	.....	.....	23.37	871	.....	.....	4
5	Yard manure, 2½ tons	24.06	1,030	5.80	313	31.46	1,205	7.84	299	5
6	" " 5 "	31.48	1,268	12.82	480	38.56	1,671	14.71	730	6
7	None	19.06	860	.....	.....	24.10	977	.....	.....	7
8	Acid phosphate, 160; muriate potash, 100; nitrate soda, 320	47.18	2,440	27.96	1,562	48.50	2,368	24.01	1,392	8
9	" " 110; " " 100; " " 320	44.45	2,247	25.08	1,350	46.63	2,220	21.79	1,247	9
10	None	19.53	915	.....	.....	25.23	972	.....	.....	10
	Average unfértilized yield	18.39	780	.. ..	.....	23.51	899	.....	.....	
	Wheat									
1	None	8.53	1,270	.....	.....	8.12	1,100	.....	.....	1
2	Acid phos., 160; mur. potash, 100; nit. soda, 120; dried blood, 50	28.95	3,540	20.10	2,309	19.70	2,442	11.42	1,380	2
3	" " 45; " " 30; " " 120; " " 50	22.46	2,657	13.29	1,466	15.51	1,841	7.09	817	3
4	None	9.49	1,152	.. ..	.....	8.57	986	.....	.....	4
5	Yard manure, 2½ tons	22.33	2,431	12.60	1,151	13.26	1,648	4.72	654	5
6	" " 5 "	30.04	3,365	20.08	1,956	17.24	2,143	8.73	1,139	6
7	None	10.20	1,537	.....	.....	8.48	1,012	.....	.....	7
8	Acid phos., 160; mur. potash, 100, nit. soda, 200; dried blood, 50	32.97	3,727	23.73	2,345	22 28	2,814	14.05	1,838	8
9	" " 90; " " 60; " " 200; " " 50	29 65	3,274	21 37	2,048	20.19	2,396	12.22	1,455	9
10	None	7.32	1,071	.....	.....	7.72	905	.....	.....	10
	Average unfertilized yield	8 88	1 257	. .	.....	8.22	1 000	.. ..	. ..	

THE 5-YEAR ROTATION.

In this experiment corn, oats, wheat, clover and timothy are grown in succession on five tracts of land, A, B, C, D and E, containing 30 one-tenth acre plots each. Sections A and B of this test lie in Range VIII, south of the areas devoted to continuous cropping, while Sections C, D and E occupy Range IX, near the east side of the farm.

The land was underdrained in 1893, and corn was grown that season on Section C. The planting was delayed by the draining and the season proved unfavorable, so that the results of that season's work have not been included in the average. In 1894 wheat was harvested on Section A, oats on Section C and corn on Section D. The clover and timothy followed the wheat on Section A in 1895 and 1896, and the rotation has since been regularly followed.

Beginning with 1900 lime has been applied to the west half of each plot in this rotation, fertilized and unfertilized alike, while the land was being prepared for corn, the lime being applied at the rate of one ton per acre of ground quicklime in 1900, 1901, 1902 and 1903, applied in the spring after plowing, and for 1904 applied the previous fall. In 1905 the liming was changed to the east half, a ton of quicklime being used that spring, but in 1906 and 1907 ground limestone was used, at the rate of two tons per acre. In 1908 the liming was discontinued. The table gives the average yield for the entire plot in each case, averaging the limed and unlimed halves.

In 1895 and 1906, and again in 1899, 1900 and 1901 the wheat in this test was injured by Hessian fly, the yield on the unfertilized land falling to a small fraction over one bushel per acre in 1896 and 1900.

Diagram II shows the arrangement of plots and plan of fertilizing one of the sections in this experiment, the five sections being arranged and treated exactly alike. Tables II to X inclusive give the yields per acre.

DIAGRAM II: PLAN OF FERTILIZING IN 5-YEAR ROTATION

Plots one-tenth acre—Fertilizing materials in pounds per acre

Plot No.	On corn			On oats			On wheat			
	Acid phosphate	Muriate of potash	Nitrate of soda	Acid phosphate	Muriate of potash	Nitrate of soda	Acid phosphate	Muriate of potash	Dried blood	Nitrate of soda
1	....	....	....	....	....	.. .	....	....	....	....
2	80	....	....	80	....	....	160	....	....	....
3	....	80	....	....	80	....	....	100	....	....
4	....	....	....	....	....	....	.. .	....	....	....
5	....	....	160	....	....	160	....	....	50	120
6	80	....	160	80	....	160	160	....	50	120
7	....	....	....	....	....	....	....	....	....	....
8	80	80	....	80	80	....	160	100	....	.. .
9	....	80	160	....	80	160	....	100	50	120
10	....	....	....	....	....	....	.. .	....	....	....
11	80	80	160	80	80	160	160	100	50	120
12	80	80	240	80	80	240	160	100	50	200
13	....	....	....	....	....	....	....	....	....	....
14	80	80	160	....	....	....	160	100	50	120
15	....	....	....	....	....	....	160	100	50	120
16	....	....	....	....	....	....	....	....	....	....
17	160	80	80	160	80	80	160	100	25	60
18	Barnyard manure, 8 tons on corn and wheat									
19	....	....	....	....	....	....	...	....	....	....
20	Barnyard manure, 4 tons on corn and wheat									
21	Same elements as 17, but nitrogen in oilmeal									
22	....	....	....	....	....	....	....	....	....	. .
23	Same elements as 17, but nitrogen in dried blood									
24	Same elements as 17, but nitrogen in sulphate ammonia									
25	....	...	.. .	....	....	...	....	....	....	...
26	Same elements as 11, but phosphorus in bone meal									
27	Same elements as 11, but phosphorus in dissolved bone black*									
28	....	....	....	....	....	....	....	....	....	. .
29	Same elements as 11, but phosphorus in basic slag									
30	Same elements as 17, but nitrogen in tankage									

*Previous to 1910. Since 1910 nitrogen in nitrate of lime and phosphorus in acid phosphate.

TABLE II: YIELD AND INCREASE PER ACRE OF *CORN* GROWN IN 5-YEAR ROTATION: 1908 AND 15 YEARS, 1894 TO 1908.

Plot	Fertilizing materials	1908				15 years, 1894-1908				Plot
		Yield		Increase		Yield		Increase		
		Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	
No.	Pounds per acre.	Bus.	Lbs.	Bus.	Lbs.	Bus.	Lbs.	Bus.	Lbs.	No.
1	None	23.35	1 410	.....	.....	31.72	1,664	.....	.....	1
2	Acid phosphate, 80	33.89	1 740	10.09	313	39.42	1,891	7.83	231	2
3	Muriate potash, 80	26.68	1,710	2.42	267	36.21	1,924	4.74	266	3
4	None	24.71	1,460	.....	.....	31.34	1,655	.....	.....	4
5	Nitrate soda, 160	33.71	1,690	7.59	187	36.33	1,831	4.69	176	5
6	Acid phosphate, 80; nitrate soda, 160	43.36	1,870	15.84	323	45.96	2,018	14.03	362	6
7	None	28.93	1,590	.....	.....	32.22	1,657	.....	.....	7
8	Acid phosphate, 80; muriate potash, 80	42.86	2,020	14.32	413	45.10	2,182	13.60	551	8
9	Muriate potash, 80; nitrate soda, 160	35.07	1,730	6.93	107	36.69	1,905	5.92	300	9
10	None	27.75	1,640	.....	.....	30.05	1,579	.....	.....	10
11	Acid phosphate, 80; muriate potash, 80: nitrate soda, 160	44.64	2,040	17.92	450	48.44	2,273	18.07	668	11
12	" " 80; " " 80; " " 240	43.32	2,000	17.50	460	48.71	2,288	18.02	658	12
13	None	24.85	1,490	.....	.....	31.02	1,655	.....	.....	13
14	Acid phosphate, 80; muriate potash, 80; nitrate soda, 160*	38.21	1,700	13.89	157	45.87	2,208	15.66	555	14
15	Fertilized on wheat only	28.86	1,740	5.10	143	35.88	1,850	7.76	236	15
16	None	23.25	1,650	.....	.....	28.65	1,648	.....	.....	16
17	Acid phosphate, 160; muriate potash, 80; nitrate soda, 80†	44.96	1,780	20.16	123	47.17	2,253	17.72	576	17
18	Barnyard manure, 8 tons each on corn and wheat	54.32	2,110	27.94	447	50.65	2,405	19.94	698	18
19	None	27.93	1,670	.....	.....	32.32	1,736	.....	.....	19
20	Barnyard manure, 4 tons each on corn and wheat	42.25	1,970	14.58	327	44.10	2,174	12.89	463	20
21	Same elements as 17, but nitrogen in oilmeal	43.03	1,900	15.63	283	46.83	2,254	16.73	567	21
22	None	27.14	1,590	.....	.....	28.99	1,662	.....	.....	22
23	Same elements as 17, but nitrogen in dried blood	46.39	2,000	18.30	377	46.91	2,254	16.92	563	23
24	Same elements as 17, but nitrogen in sulphate ammonia	50.75	1,850	21.70	193	47.68	2,289	16.70	568	24
25	None	30.00	1,690	.....	.....	31.98	1,749	.....	.....	25
26	Same elements as 11, but phosphorus in bonemeal	43 64	2,190	10.51	403	46.91	2,319	14.18	542	26
27	Same elements as 11, but phosphorus in dissolved bone black	48.25	2,040	11.99	157	48.22	2,307	14.73	501	27
28	None	39.39	1,980	.....	.....	34.25	1.834	.....	.....	28
29	Same elements as 11 but phosphorus in basic slag	49.25	2,370	9.86	390	49.33	2,410	15.09	576	29
30	Same elements as 17, but nitrogen in tankage‡	52 11	2,020	12 72	40	47.70	2,235	13.46	400	30
	A verage unfertilized yield	27.71	1 617	.....	.....	31.25	1,683	.....	.....	

* Fertilized on corn and wheat only. †Since first rotation: previously same quantities of elements as 11. ‡Since second rotation: previously this plot received less fertilizer.

TABLE III: YIELD AND INCREASE PER ACRE OF *CORN* BY 5-YEAR PERIODS. GRAIN ONLY.

Plot	Fertiizing materials.	1894-1898		1899-1903		1904-1908		Plot
		Yield	Increase	Yield	Increase	Yield	Increase	
No.	Pounds per acre.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	No.
2	Acid phosphate, 80	36.02	3.96	41.90	9.74	40.33	9.78	2
3	Muriate potash, 80	34.93	2.69	36.14	4.74	37.55	6.79	3
5	Nitrate soda, 160	35.38	2.33	36.24	5.75	37.37	6.01	5
6	Acid phosphate, 80, nitrate soda, 160	43.32	9.65	47.61	17.26	46 95	15.17	6
8	Acid phosphate, 80: muriate potash, 80	40.11	7.21	44.49	14.17	50.69	19.40	8
9	Muriate potash, 80; nitrate soda, 160	33.00	1.48	36.62	6.19	40.47	10.10	9
11	Acid phosphate, 80; muriate potash, 80; nitrate soda, 160	41.28	10.72	49.90	19.45	54.13	24.04	11
12	" " 80: " " 80; " " 240	41.07	10.09	52.18	21.82	52.88	22.14	12
14	Acid phosphate, 80; muriate potash, 80; nitrate soda, 160	40 96	10.27	47.81	18.33	48.85	18.37	14
15	Fertilized on wheat only	32.26	5.92	35.52	6.83	39.13	9.42	15
17	Acid phosphate, 160; muriate potash, 80; nitrate soda, 80	35.78	6 59	49.54	20.48	53.91	23.87	17
18	Barnyard manure, 8 tons each on corn and wheat	40.73	10 04	49.52	19.32	59.75	28 48	18
20	Barnyard manure, 4 tons each on corn and wheat	38 91	7.10	43.08	12.83	50 31	18.74	20
21	Same elements as 17, but nitrogen in oilmeal	37.66	7.16	48.79	19.63	54.03	23 39	21
23	Same elements as 17, but nitrogen in dried blood	37.68	7 71	49.51	19 90	53 53	23.16	23
24	Same elements as 17, but nitrogen in sulphate ammonia	40.51	9 75	49.44	18.27	53.11	22.08	24
26	Same elements as 11, but phosphorus in bonemeal	39.14	6 22	50.31	17.30	51.28	19.01	26
27	Same elements as 11, but phosphorus in dissolved boneblack	40 61	6.29	53 25	19 96	50 81	17.95	27
29	Same elements as 11, but phosphorus in basic slag	43.89	8.19	53.36	19 77	50.75	17.30	29
30	Same elements as 17, but nitrogen in tankage	41.73	6.02	46.51	12 93	54.87	21.42	30
	Average unfertilized yield	31.89	.....	30.82	.....	31.04	.. ..	

Table III shows that there has been a general increase in the yield per acre on the fertilized and manured plots during the three periods of the experiment, while the unfertilized yield has remained almost stationary. This increase has been much greater on the plots receiving the complete fertilizer, containing the three elements, nitrogen, phosphorus and potassium, than on those receiving only one or two elements. The use of lime has improved the yield during the last period, but the lime has been applied to fertilized and unfertilized land alike.

TABLE IV: YIELD AND INCREASE PER ACRE OF *OATS* GROWN IN 5-YEAR ROTATION: 1908, AND 15 YEARS, 1894-1908.

Plot	Fertilizing materials	1908				15 years, 1894-1908				Plot
		Yield		Increase		Yield		Increase		
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	
No.	Pounds per acre.	Bus.	Lbs.	Bus.	Lbs.	Bus.	Lbs.	Bus.	Lbs.	No.
1	None	45.54	2,102	.....	.....	32.59	1,313	.....	.....	1
2	Acid phosphate, 80	52.73	2,482	9.61	332	40.24	1,655	7.97	281	2
3	Muriate potash, 80	50.86	2,627	10 16	430	35.59	1 386	3.64	99	3
4	None	38.28	2,245	.....	.....	31 63	1,273	.....	.....	4
5	Nitrate soda, 160	41.09	2,335	2 53	173	35 70	1,415	4.19	155	5
6	Acid phosphate, 80; nitrate soda, 160	53.75	2,750	14 90	670	46.50	1,847	15.11	601	6
7	None	39.14	1,997	.....	.....	31.27	1 233	.....	.....	7
8	Acid phosphate, 80; muriate potash, 180	55.15	3,085	13.36	946	42 69	1,677	11.31	512	8
9	Muriate potash, 80; nitrate soda, 160	46 48	2,462	2.03	182	36 23	1,488	4 75	257	9
10	None	47.10	2,422	.....	.....	31.59	1,230	.....	.....	10
11	Acid phosphate, 80; muriate potash, 80; nitrate soda, 160	53 75	3,350	9 51	993	49.86	2,155	18.33	901	11
12	" " 80; " " 80; " " 240	48.36	3,132	6.98	540	48.88	2,230	17.42	952	12
13	None	38.51	2,227	.....	.....	31 40	1,301	.....	.....	13
14	Fertilized on corn and wheat only	48.28	2,665	8.70	509	38.89	1,651	8.13	396	14
15	Fertilized on wheat only	42.65	2,375	2.00	289	32.34	1,301	2.47	127	15
16	None	41.72	2,015	.....	.....	29.50	1,167	.....	.....	16
17	Acid phosphate, 160; muriate potash, 80; nitrate soda, 80*	56 32	3,627	14 50	1,499	47.39	2,126	17.49	930	17
18	Manured on corn and wheat	47 42	2,962	5.49	720	38.87	1,743	10.71	641	18
19	None	42.03	2,355	.....	.....	30.72	1,252	.....	.....	19
20	Manured on corn and wheat	48 59	2,745	6.77	448	36.95	1,560	6.51	328	20
21	Same elements as 17, but nitrogen in oilmeal	55.62	3,560	14.00	1,318	46 72	2,066	15.44	779	21
22	None	41.41	2,185	.....	.....	29.86	1,194	.....	.....	22
23	Same elements as 17, but nitrogen in dried blood	53.51	3,347	12.10	1,095	46.85	2,008	16.50	776	23
24	Same elements as 17, but nitrogen in sulphate ammonia	54.92	3,632	13.57	1,312	48.27	2,220	17.43	948	24
25	None	41.32	2,387	.....	.....	31 34	1,312	.....	.....	25
26	Same elements as 11, but phosphorus in bonemeal	50.78	3,115	10.58	799	46 71	1,970	14.98	673	26
27	Same elemente as 11, but phosphorus in dissolved boneblack	47.11	3,262	8.02	1,016	49 35	2,163	17.22	881	27
28	None	37.97	2,175	.....	.....	32 52	1,267	.....	.....	28
29	Same elements as 11, but phosphorus in basic slag	44.92	3,202	6 95	1,027	47.42	2,012	14.90	744	29
30	Same elements as 17, but nitrogen in tankage†	45.39	3,047	7.42	872	43.69	1,836	11.17	569	30
	Average unfertilized yield	41 30	2 241	.....	.....	31.24	1 256	.....	...	

* Since first rotation: previously same quantities of elements as 11. † Since second rotation: previously this plot received less fertilizer.

TABLE V: YIELD AND INCREASE PER ACRE OF *OATS* BY 5-YEAR PERIODS. GRAIN ONLY.

Plot	Fertilizing materials.	1894-1899		1899-1903		1894-1908		Plot
		Yield	Increase	Yield	Increase	Yield	Increase	
No.	Pounds per acre.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	No.
2	Acid phosphate, 80	37.63	5.34	37.37	8 66	45.72	9 91	2
3	Muriate potash, 80	34.71	2.32	33.70	4 62	38 34	3 97	3
5	Nitrate soda, 160	35.40	3.11	34 89	5.95	36 80	3 50	5
6	Acid phosphate, 80; nitrate soda, 160	40.36	8 26	48 75	20.32	50 41	16 75	6
8	Acid phosphate, 80; muriate potash, 180	38.26	6.87	40 92	12.72	48 89	14.34	8
9	Muriate potash, 80; nitrate soda, 160	33.36	2 46	35 75	7.26	39 60	4.53	9
11	Acid phosphate, 80; muriate potash, 80; nitrate soda, 160	43 61	12.92	52.48	23 74	53 49	18.35	11
12	Acid phosphate, 80; muriate potash, 80; nitrate soda, 240	45 11	14 11	52.37	23 65	49.16	14.49	12
14	Fertilized on corn and wheat only	36.79	6 19	37.18	9.23	42.69	8 95	14
15	Fertilized on wheat only	30 31	.....	30.25	3 51	36 46	3.19	15
17	Acid phosphate, 160; muriate potash, 80; nitrate soda, 80	38.03	8 57	49 19	22 51	54 97	21.68	17
18	Manured on corn and wheat	36.91	5.20	40 36	12.90	46 71	12.93	18
20	Manured on corn and wheat	32.39	2.58	36 45	9.05	42 00	7.90	20
21	Same elements as 17, but nitrogen in oilmeal	37.43	7.78	50.64	24 51	52 87	18 93	21
23	Same elements as 17, but nitrogen in dried blood	39.81	9 94	48.67	21 75	52 06	17 80	23
24	Same elements as 17, but nitrogen in sulphate ammonia	43.01	12.76	49 29	21 79	52 52	17 73	24
26	Same elements as 11, but phosphorus in bonemeal	43.04	12 11	47 11	18 00	49 98	14.82	26
27	Same elements as 11 but phosphorus in dissolved boneblack	43.54	12.29	51 59	21 48	52.91	17 89	27
29	Same elements as 11, but phosphorus in basic slag	42.49	10 93	49 19	18 08	50 58	15 70	29
30	Same elements as 17, but nitrogen in tankage	35.47	3.91	45.78	14 65	49 83	14.96	30
	Average unfertilized yield	30.91	....	28.30	....	34 50	....	
	Average yield and increase from complete fertilizers	39.89	10 14	46 98	18 55	49.79	15.37	

The oats crop shows a marked increase in the unfertilized yield during the third period of the test, the gain on the unfertilized plots being much larger than that on those receiving fertilizers and manure, the result of which is an apparent falling off in the effectiveness of the fertilizer. The total yields, however, are larger during the third period than during the second on every plot except No. 12, receiving the heavy dressing of nitrate of soda. The increasing tendency to lodge on this plot probably accounts for its smaller yield. The manured plots show a smaller increase of oats than those receiving the complete fertilizers, but the manure is all applied to the corn and wheat. The outcome on these plots, as on Plots 14 and 15, indicates that it is better to apply manure and fertilizers to every crop, rather than only to certain crops in the rotation.

TABLE VI: YIELD AND INCREASE PER ACRE OF *WHEAT* GROWN IN 5-YEAR ROTATION: 1907, AND 15 YEARS, 1894 TO 1908.

Plot	Fertilizing materials.	1908				15 years, 1894-1908				Plot
		Yield		Increase		Yield		Increase		
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	
No.	Pounds per acre	Bus.	Lbs.	Bus.	Lbs.	Bus.	Lbs.	Bus.	Lbs.	No.
1	None	21.16	2,350	.....	.....	10.42	1,128	.....	.....	1
2	Acid phosphate, 160	30.16	2,770	9.22	493	18 38	1,851	7.83	727	2
3	Muriate potash, 100	22.45	2,302	1 73	99	11.97	1,275	1 29	156	3
4	None	20.50	2,130	.....	.....	10.81	1,118	.....	.....	4
5	Dried blood, 50; nitrate soda, 120	22.12	2,492	1 90	495	12.77	1,421	1.96	303	5
6	Acid phosphate, 160; dried blood, 50; nitrate soda, 120	37.12	3,442	17.18	1,579	24.06	2,456	13.24	1,335	6
7	None	19.66	1,730	.....	.....	10.81	1,123	.....	.....	7
8	Acid phosphate, 160; muriate potash, 100	29.54	2,797	9.27	947	19.65	1,846	8.86	741	8
9	Muriate potash, 100; dried blood, 50; nitrate soda, 120	24.25	2,725	3 37	755	13.51	1,440	2.75	353	9
10	None	21.49	2,090	.....	.....	10.73	1,069	.....	.....	10
11	Acid phos., 160; mur. potash, 100; dried blood, 50; nit. soda, 120	41.45	4,002	20.03	1,968	27.03	2,846	16.30	1,766	11
12	Acid phos., 160; mur. potash, 100; dried blood, 50; nit. soda, 200	35 58	4,015	14.22	2,037	27.97	2,929	17.20	1,838	12
13	None	21.29	1,922	.....	.....	10.79	1,101	.....	.....	13
14	Acid phos., 160; mur. potash, 100; dried blood, 50; nit. soda. 120[1]	39.70	3,747	20.40	1,959	25.25	2,633	14.89	1,585	14
15	Acid phos., 160; mur. potash, 100; dried blood, 50; nit. soda, 120[2]	34.75	3,085	17 43	1,431	24.01	2,453	14.08	1,459	15
16	None	15.33	1,520	.....	.....	9.51	941	.....	.....	16
17	Acid phos., 160; mur. potash, 100; dried blood, 25; nit. soda, 60[3]	34.16	3,250	18.11	1,647	22.11	2,211	12.35	1,234	17
18	Barnyard manure, 8 tons	33.25	2,955	16.47	1,268	20.55	2,200	10 54	1,187	18
19	None	17.50	1,770	.....	.....	10.26	1,049	.....	.....	19
20	Barnyard manure, 4 tons	27.46	2,582	9.78	806	16.87	1,809	6.72	781	20
21	Same elements as 17, but nitrogen in oilmeal	31.16	2,850	13.30	1,069	23.39	2,407	13.36	1,400	21
22	None	18.04	1,787	.....	.....	9.92	986	.....	.....	22
23	Same elements as 17, but nitrogen in dried blood	31.71	2,837	13.46	986	22.18	2,187	11.93	1,153	23
24	Same elements as 17, but nitrogen in sulphate ammonia	32 79	3,052	14.35	1,136	22.77	2,264	12.20	1,182	24
25	None	18.66	1,980	.....	.....	10.90	1,129	.....	.....	25
26	Same elements as 11, but phosphorus in bone meal	31.95	2,782	13.32	937	23.49	2,372	12.69	1,282	26
27	Same elements as 11, but phosphorus in dissolved boneblack	35.83	3,390	17.22	1,680	26.36	2,639	15.65	1,589	27
28	None	18.58	1,575	.....	.....	10.63	1,011	.....	.....	28
29	Same elements as 11, but phosphorus in basic slag	33.37	3,157	14.79	1,582	24 61	2,518	13.98	1,506	29
30	Same elements as 17, but nitrogen in tankage[4]	30.50	2,900	11.92	1 325	21.97	2 119	11.34	1,108	30
	Average unfertilized yield	19.50	1 932			10.49	1,068			

[1] Fertilized on corn and wheat only. [2] Fertilized on wheat only, previously this plot received less fertilizer. [3] Since first rotation; previously same quantities of elements as 11. [4] Since second rotation; previously this plot received less fertilizer.

TABLE VII—YIELD AND INCREASE PER ACRE OF *WHEAT* BY 5-YEAR PERIODS, GRAIN ONLY.

Plot.	Fertilizing materials.	1894-1898		1899-1903		1904-1908		Plot
		Yield	Increase	Yield	Increase	Yield	Increase	
	Pounds per acre	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	
2	Acid phosphate, 160	12.35	3.14	18.67	9.81	24.13	10.54	2
3	Muriate potash, 100	11.26	1.64	9.54	.86	15.11	1.37	3
5	Dried blood, 50; nitrate soda, 120	11 57	1.54	10 58	2.10	16.16	2.23	5
6	Acid phosphate, 160; dried blood, 50; nitrate soda, 120	16.84	6.81	24.47	16.00	30.87	16 92	6
8	Acid phosphate, 160; muriate potash, 100	15 20	5.22	19.78	11.31	23 96	10.06	8
9	Muriate potash, 100; dried blood, 50; nitrate soda, 120	12.09	2.15	11.12	2.61	17 31	3.48	9
11	Acid phosphate, 160; muriate potash, 100; dried blood, 50; nitrate soda, 120	20.53	10 73	27.46	18.82	33.10	19.32	11
12	Acid phosphate, 160; muriate potash, 100; dried blood, 50; nitrate soda, 200	20 95	11.23	29.37	20.61	33.58	19.77	12
14	Acid phosphate, 160; muriate potash, 100; dried blood, 50; nitrate soda, 120	18.11	8.92	25.55	17.10	32.10	18.65	14
15	Acid phosphate, 160; muriate potash, 100; dried blood, 50; nitrate soda, 120	16.77	8.04	24.80	16 80	30.46	17.39	15
17	Acid phosphate, 160; muriate potash, 100; dried blood, 25; nitrate soda, 60	13.84	5.55	23.20	15.39	29.28	16.11	17
18	Barnyard manure, 8 tons	12.65	4 35	19 02	10.97	29 97	16.29	18
20	Barnyard manure, 4 tons	11 48	3.25	14 67	6.41	24.47	10.52	20
21	Same elements as 17, but nitrogen in oilmeal	18 35	10.20	23.88	15.66	27.95	14.24	21
23	Same elements as 17, but nitrogen in dried blood	16 78	8 14	23 28	14.71	26.47	12 95	23
24	Same elements as 17, but nitrogen in sulphate ammonia	17 85	8 64	22 97	14 02	27.48	13.93	24
26	Same elements as 11, but phosphorus in bone meal	18.17	8.33	24 18	15.07	28.12	14 66	26
27	Same elements as 11, but phosphorus in dissolved boneblack	18.86	8 94	28.72	19.81	31.53	18.20	27
29	Same elements as 11, but phosphorus in basic slag	18.71	8.73	26 58	17 88	28 54	15 34	29
30	Same elements as 17, but nitrogen in tankage	14.66	4.68	23,90	15 20	27 35	14.15	30
	Average unfertilized yield	9.28	....	8.55	..	13 66	....	
	Average yield and increase from complete fertilizers	17.88	7.51	16.76	25 32	29.66	16 23	

The wheat crop, like the oats, shows a large increase in the unfertilized yield during the third period as compared with either of those preceding. This is due in part to better seasonal conditions, in part to the use of lime during the last period, but chiefly to the deliverance from insect depredations, there having been severe attacks of Hessian fly in 1895 and 1896 and again in 1899 to 1901. While, therefore, the total yield is much larger on every plot during the third period than before, the average increase from the fertilizers is not any greater.

TABLE VIII: YIELD AND INCREASE PER ACRE OF *CLOVER* AND *TIMOTHY* GROWN IN 5-YEAR ROTATION: 1908 AND DURING THE ENTIRE PERIOD OF THE EXPERIMENT.

Plot	Total quantities of fertilizing materials appl id to previous crops of the rotation. None on clover or timothy.	1908				Entire period				Plot
		Clover		Timothy		Clover, 14 years		Timothy, 13 years		
		Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
No.	Pounds per acre	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	No.
1	None	3,013	.....	2,062	.....	1,818	.....	2,853	.....	1
2	Acid phosphate, 320	5,404	2,560	3,004	957	2,410	552	3,079	266	2
3	Muriate potash, 260	5,289	2,614	2,106	74	2,165	266	2,915	141	3
4	None	2,506	.....	2,017	.....	1,939	.....	2,734	.....	4
5	Nitrate soda, 440; dried blood, 50	2,880	430	2,889	854	2,251	352	3,138	456	5
6	Acid phosphate, 320; nitrate soda, 440; dried blood, 50	5,493	3,100	3,492	1,439	2,997	1,139	3,438	809	6
7	None	2,337	.....	2,070	.....	1,818	.....	2,578	.....	7
8	Acid phosphate, 320; muriate potash, 260	6,035	3,858	3,324	1,229	2,738	916	3,046	490	8
9	Muriate potash, 260; nitrate soda, 440; dried blood, 50	2,426	408	2,747	629	2,187	362	2,931	396	9
10	None	1,858	.....	2,142	.....	1,828	.....	2,515	.....	10
11	Acid phos., 320; mur. potash, 260; nit. soda, 440; dried blood, 50	4,968	3,018	4,195	1,940	3,123	1,317	3,582	1,053	11
12	Acid phos., 320; mur. potash, 260; nit. soda, 680; dried blood, 50	5,440	3,399	4,187	1,820	3,229	1,445	3,474	931	12
13	None	2,133	.....	2,480	.....	1,763	.....	2,556	.....	13
14	Acid phos., 240; mur. potash, 18; nit. soda, 280; dried blood, 50	4,018	1,986	3,102	705	2,762	1,041	3,210	691	14
15	Acid phos., 160; mur. potash, 10; nit. soda, 120; dried blood, 50	3,422	1,490	2,800	485	2,347	670	2,910	427	15
16	None	1,831	.....	2,231	.....	1,636	.....	2,446	.....	16
17	Acid phos., 480; mur. potash, 260; nit. soda, 220; dried blood, 25	5,484	3,543	3,982	1,703	2,906	1,223	3,186	697	17
18	Yard manure, 16 tons	6,400	4,350	5,528	3,202	3,659	1,927	4,014	1,482	18
19	None	2,160	.....	2,373	.....	1,777	.....	2,574	.....	19
20	Yard manure, 8 tons	3,964	2,035	4,346	2,213	2,809	1,116	3,446	961	20
21	Same elements as 17, but nitrogen in oilmeal	4,871	3,173	3,315	1,422	2,636	1,026	3,050	655	21
22	None	1,467	.....	1,653	.....	1,526	.....	2,306	.....	22
23	Same elements as 17, but nitrogen in dried blood	4,978	3,455	2,986	1,152	2,601	990	3,022	614	23
24	Same elements as 17, but nitrogen in sulphate ammonia	5,813	4,234	3,395	1,380	2,718	1,023	2,948	439	24
25	None	1,635	.....	2,195	.....	1,779	.....	2,611	.....	25
26	Same elements as 11, but phosphorus in bonemeal	6,631	4,777	3,848	1,748	3,293	1,468	3,637	946	26
27	Same elements as 11, but phosphorus in dissolved boneblack	5,582	3,508	3,342	1,336	2,893	1,023	3,449	681	27
28	None	2,293	.....	1,911	.....	1,916	.....	2,847	.....	28
29	Same elements as 11, but phosphorus in basic slag	5,671	3,378	3,600	1,689	3,064	1,148	3,797	950	29
30	Same elements as 17, but nitrogen in tankage	6,400	4,107	3,813	1,902	3 046	1 130	3,743	896	30
	Average unfertilized yield	2 123		2 113		1 780		2,602		

TABLE IX: YIELD AND INCREASE PER ACRE OF *CLOVER* AND *TIMOTHY* HAY BY PERIODS.

Plot	Clover						Timothy						Plot
	5 years, 1895-1899		5 years, 1900-1904		4 years, 1905-1908		5 years, 1896-1900		5 years, 1901-1905		3 years, 1906-1908		
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
No.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	No.
2	2,120	387	2,018	273	3,163	1,033	2,882	186	2,802	67	3,869	730	2
3	1,934	117	1,768	36	2,852	682	3,014	336	2,600	-28	3,277	97	3
5	1,984	100	2,130	489	2,705	528	2,842	213	2,894	449	4,039	873	5
6	2,798	930	2,397	834	3,849	1,707	3,116	517	3,156	786	4,444	1,334	6
8	2,574	690	1,909	420	3,771	1,694	2,850	337	2,740	441	3,884	827	8
9	2,258	342	1,857	365	2,428	384	2,680	225	2,801	501	3,565	506	9
11	2,952	989	2,613	1,165	3,848	1,878	3,246	819	3,311	960	4,593	1,597	11
12	3,076	1,097	2,663	1,264	3,986	2,058	2,942	491	3,361	959	4,548	1,618	12
14	2,858	944	2,201	886	3,203	1,318	3,082	623	2,966	609	3,831	941	14
15	2,400	564	1,797	524	2,831	947	2,846	405	2,626	362	3,490	575	15
17	2,365	685	2,221	927	4,052	2,115	2,898	445	2,748	549	4,394	1,362	17
18	3,075	1,237	2,870	1,518	5,139	3,198	3,520	1,037	3,430	1,204	5,809	2,686	18
20	2,556	761	2,200	855	3,736	1,821	3,082	655	2,908	747	4,948	1,826	20
21	2,526	793	1,910	631	3,501	1,714	2,790	447	2,662	593	4,130	1,101	21
22	2,518	779	1,894	616	3,412	1,636	2,824	467	2,593	534	4,068	994	23
24	2,486	679	1,946	590	3,779	1,884	2,784	327	2,604	463	3,795	582	24
26	2,686	842	2,746	1,250	4,600	2,469	3,358	709	3,200	913	4,829	1,401	26
27	2,422	610	2,343	778	4,032	1,786	3,268	525	3,005	653	4,492	984	27
29	2,512	728	2,737	1,105	4,081	1,715	3,686	850	3,378	962	4,678	1,093	29
30	2,460	676	2,366	733	4,460	2,094	3,538	702	3,232	816	4,938	1,353	30
*	1,829	....	1,473	....	2,027	.....	2,541	....	2,276	..	3,133	....	
**	2,605	782	2,286	872	3,815	1,801	3,105	567	2,974	698	4,317	1,133	

* Average unfertilized yield. ** Average total yield and increase from complete fertilizers.

Table IX shows that there was a general falling off in the yield of hay during the second period on the fertilized and manured land, as well as on that left untreated. In the case of the clover crop the only exceptions to this rule of diminishing yields are found on Plot 5, receiving nitrate of soda only, and Plots 26 and 29, to which the phosphorus has been given in bone meal and basic slag, respectively, instead of acid phosphate. The reduction in yield has been smaller on all the plots receiving nitrate of soda than on those receiving other carriers of nitrogen. (Plots 21, 23 and 24) On these plots both total yield and rate of increase are less during the second period than during the first. Plot 30 cannot be compared during this period, as a change in the fertilizer of this plot was made at the beginning of the second period. During the third period, under the influence of lime, there has been a marked gain, both in the total yield and the rate of increase.

TABLE X: TOTAL FERTILIZING MATERIALS AND THEIR COST FOR EACH ROTATION, AND TOTAL AND NET VALUE OF INCREASE PRODUCED FOR 5-YEAR PERIODS AND FOR 15 YEARS.

Plot No.	Fertilizing materials in pounds per acre for each rotation.	Cost of fertilizers	Total value of increase per acre				Net gain or loss (—) from fertilizers				Plot No.
			First 5 years	Second 5 years	Third 5 years	15-year average	First 5-years	Second 5-years	Third 5-years	15-year average	
2	Acid phosphate, 320	$ 2.60	$ 8.50	$17.37	$24.32	$16 43	$ 5.90	$14.77	$21.72	$13 83	2
3	Muriate potash, 260	6.50	5.19	4.67	9.17	6.31	—1.31	—1.83	2 67	—.19	3
5	Nitrate soda, 440; dried blood, 50	14.40	4.70	10 40	9.03	8.67	—9.70	—4.00	—5 37	—5 73	5
6	Acid phosphate, 320; nitrate soda, 440; dried blood, 50	17.00	19.09	35.27	39 75	31.00	2.09	18.27	22 75	14 00	6
8	Acid phosphate, 320; muriate potash, 260	9.10	14.40	24.37	33.51	23.62	5.30	15.27	24 41	14 52	8
9	Muriate potash, 260; nitrate soda, 440; dried blood, 50	20.90	5.85	11.35	13.23	10 09	—15.05	—9 55	—6.67	—10 81	9
11	Acid phos., 320; mur. potash, 260; nit. soda, 440; dried blood, 50	23.50	26.39	42.43	49.96	38 94	2.80	18.93	26.46	15.44	11
12	Acid phos., 320, mur. potash, 260; nit. soda, 680; dried blood, 50	30 70	26.16	45.53	48.24	39.50	—4.54	14.83	17.54	8.80	12
14	Acid phos., 240; mur. potash, 180; nit. soda, 280; dried blood, 50	16.05	21.37	32.91	37.33	30.37	5.32	15.86	21.28	14.32	14
15	Acid phos., 160; mur. potash, 100; nit. soda, 120; dried blood, 50	8.60	13.89	22.86	27.13	21.44	5.29	14.26	18.53	12.84	15
17	Acid phos., 480; mur. potash, 260; nit. soda, 220; dried blood, 25	17 60	15.74	36 61	46.28	32.93	—1.86	19 01	28.68	15.33	17
18	Yard manure, 16 tons	?	19.82	34.24	55.94	36.18	?	?	?	?	18
20	Yard manure, 8 tons	?	13.02	21.28	35.36	22 63	?	?	?	?	20
21	Same elements as 17, but nitrogen in oilmeal	17.60	20.43	36.25	42.24	31.77	2.83	18.65	24 64	14.17	21
23	Same elements as 17, but nitrogen in dried blood	17.60	19 09	34.37	39.28	30 45	1.49	16.77	21.68	12.85	23
24	Same elements as 17, but nitrogen in sulphate ammonia	17.60	20.70	32.77	38.71	30.48	3.10	14.77	21.11	12.88	24
26	Same elements as 11, but phosphorus in bonemeal	23.50	20.89	36.17	42.55	32.75	—2.61	12.67	19 05	9.25	26
27	Same elements as 11, but phosphorus in dissolved boneblack	23.50	19.86	39.88	42.08	33.62	—3.64	16.38	18.58	10.12	27
29	Same elements as 11, but phosphorus in basic slag	23.50	21.91	39.32	39.04	33.20	—1.59	15.82	15.54	9.70	29
30	Same elements as 17, but nitrogen in tankage	*17.60	13.74	30.51	41.62	28.21	....	12.90	24.02	10.61	30

The nearest practicable approach to a common denominator for the various kinds of produce grown in this rotation is their market value, and in Table XI the results of the test are arranged on this basis for three 5-year periods and for the entire 15 years, corn being rated at 40 cents per bushel, oats at 30 cents, wheat at 80 cents, hay at $8.00 per ton, stover at $3.00 and straw at $2.00; valuations much below present prices for the grains, but not far from the average values during the period of the test.

The fertilizing materials are valued at a fraction over $16.00 per ton for acid phosphate, 2½ cents per pound for muriate of potash and 3 cents per pound for nitrate of soda; and it is assumed that the cost per pound of the fertilizing elements will be practically the same in the other carriers used on Plots 21 to 30 inclusive.

The table shows that the effectiveness of the fertilizers and manure has increased with each successive period, the greatest relative increase being shown by the manure. Taking the second part of the table, giving the net gain after deducting the cost of the fertilizers, it will be seen that during the first period eight of the fertilizer applications failed to produce sufficient increase to cover their cost; during the second period three, and during the third period two. Every complete fertilizer has been used with a profit since the first period, but when either nitrate of soda or muriate of potash has been used unaccompanied by some carrier of phosphorus there has been a loss in each period and in the average of the 15 years.

Nevertheless, both nitrogen and potassium are essential to the highest net profit, as shown by comparing Plot 2, receiving phosphorus only, with Plot 8, receiving potassium in addition and Plot 11, receiving these with nitrogen.

The results of the comparison of different carriers of nitrogen and phosphorus will be discussed in Circular No. 93.

* For last 2 periods.

THE POTATOES-WHEAT-CLOVER ROTATION.

This experiment is located on the South farm, south-east of the orchards, and contains three sections of 34 plots each. The south section (A) and about half of the middle section (B) had been in cultivation for an unknown period before the test began. The north part of Section B and all of the north section (C) were cleared from the forest for the purposes of this test. The old land was tile drained in 1893 and the work was begun by planting Section A to potatoes in 1894. Wheat and clover followed in 1895 and 1896 and the rotation has been maintained regularly since.

The potato crops in this test have in some seasons been some what injured by blight, and in 1904 a dashing rain, coming just after the potatoes had been planted, washed much of the seed out of the ground. These difficulties have caused an irregular stand, and for this reason the results have been "corrected" on the basis of the average stand obtained on the unfertilized plots. Both actual and "corrected" yields are given in the table.

In 1895 and 1896 the wheat in this test was severely injured by Hessian fly, but it escaped the attack of 1899 to 1901.

In 1900 the clover failed: attempts were made to grow crimson clover and soy beans in its stead, but there was failure in securing a stand of these crops also, so that it has been necessary to omit that season from the calculations. In 1905 continuous rains prevented harvesting the clover until very late, and caused the fertilized plots to lodge, so that these plots weighed less than those not fertilized, though earlier in the season they had shown a distinctly stronger growth. As there was no way by which the yields could be corrected and as it seemed desirable to include the crop in the general average because of its effect on the average unfertilized yield it has been so included, although the doing so slightly reduces the apparent average effect from the fertilizers.

DIAGRAM III: PLAN OF FERTILIZING IN POTATOES-WHEAT-CLOVER ROTATION

PLOTS ONE-TENTH ACRE — Fertilizing materials in pounds per acre

Plot No.	On Potatoes			On Wheat			
	Acid Phosphate	Muriate of potash	Nitrate of soda	Acid Phosphate	Muriate of potash	Dried blood	Nitrate of soda
1	....	....	....	...	....	....	...
2	160	.. .	...	160	. ..	...	. .
3	....	100	...	. ..	100	...	....
4	....	. .	....	.. .	....	....	....
5	....	....	80	....	....	50	120
6	160	....	80	160	...	50	120
6	....	.. .	....	....	....	....	...
8	160	100	...	160	100	...	....
9	....	100	80	...	100	50	120
10	....	....	....	....	...	....	....
11	160	100	80	160	100	50	120
12	160	100	160	160	100	50	200
13	....	....	....	....	....	...	....
14	320	200	160	160	100	50	120
15	480	300	320	....	....	....	....
16	....	....	....	....	...	....	....
17	....	....	....	Manure, 4 tons on wheat			
18	....	....	....	Manure, 8 tons on wheat			
19	....	....	....	....	...	....	.. .
20	160	100	80	160	100	25	60
21	Same elements as 20, but nitrogen in oilmeal						
22	....	....	....	....	....	....	...
23	Same elements as 20, but nitrogen in dried blood						
24	Same elements as 20, but nitrogen in sulphate ammonia						
25	....	....	....	....	....	....	....
26	Same elements as 11, but phosphorus in bone meal						
27	Same elements as 11, but phosphorus in dissolved bone black						
28	....	....	....	....	....	....	....
29	Same elements as 11, but phosphorus in basic slag						
30	Manure, 8 tons on potatoes			....	....	....	....
31	....	....	...	....	....	....	....
32	....	....	...	Manure, 16 tons on wheat			
33	Same elements as 20, but nitrogen in tankage						
34	....	....	....	....	....	....	....

DIAGRAM IV; ARRANGEMENT OF PLOTS IN POTATOES-WHEAT-CLOVER ROTATION.

PLOTS ONE-TENTH ACRE.

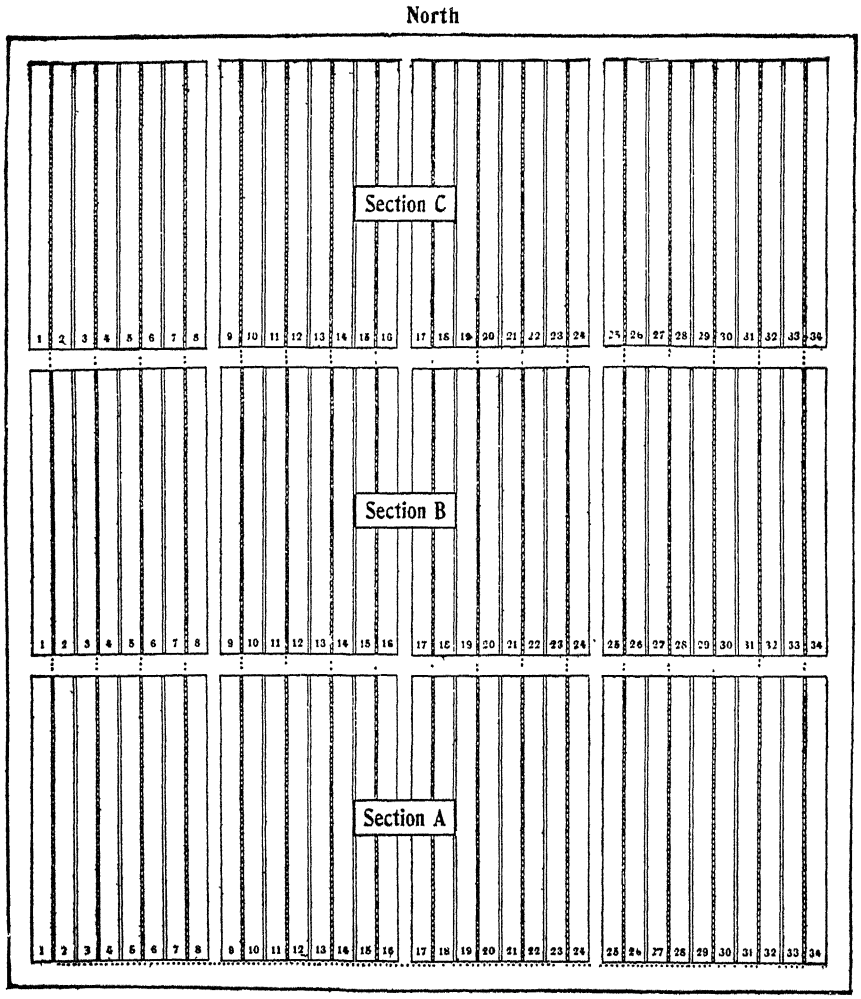


TABLE XI: YIELD AND INCREASE OF *POTATOES* GROWN IN ROTATION WITH WHEAT AND CLOVER, 1908 AND 15 YEARS, 1894-1909.

Plot No.	Fertilizing materials	1908				15 years, 1894-1909				Plot No.
		Actual		Corrected		Actual		Corrected		
		Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
	Pounds per acre	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	
1	None	118.82	.....	124.93	.....	166.05	.....	170 76	.....	1
2	Acid phosphate, 160	133.33	1.28	130 46	—3.62	182.62	14 99	185 52	14.58	2
3	Muriate potash, 100	154.75	9.48	151.97	9.47	178.79	9.52	184.83	13.71	3
4	None	158.50	.....	151.29	.....	170.87	.....	171.31	.....	4
5	Nitrate soda, 80	170.92	23.00	167.04	26.95	175.49	9.08	178 28	11.66	5
6	Acid phosphate, 160; nitrate soda, 80	135 75	—1.58	128 09	—.81	182.74	20.79	186.07	24.14	6
7	None	126.75	.....	117.70	.....	157.48	.....	157.25	.....	7
8	Acid phosphate, 160; muriate potash, 100	194.58	67.55	183.18	64.35	189.09	30.66	192.82	34.46	8
9	Muriate potash, 100; nitrate soda, 80	154.50	27.20	142.65	22.70	171.79	12.36	174.78	15.32	9
10	None	127.58	.....	121 08	.....	160.30	.....	160.56	.....	10
11	Acid phosphate, 160; muriate potash, 100; nitrate soda, 80	166.17	35.92	153 95	30.97	184.08	24 18	184 35	24.87	11
12	Acid phosphate, 160: muriate potash, 100; nitrate soda, 160	176.67	43.76	165.74	41.07	191.27	31.71	190 83	32.90	12
13	None	135.58	.....	126.47	.....	159 09	.....	157.28	.....	13
14	Acid phosphate, 320; muriate potash, 200; nitrate soda, 160	184.83	55.92	172.80	49.09	191 49	35.91	196.24	41.82	14
15	Acid phosphate, 480; muriate potash, 300; nitrate soda, 320	184.83	62.58	206 52	85.57	187.82	35.63	194 94	43.51	15
16	None	115.58	.....	118 18	.....	148 53	.....	148 50	.....	16
17	Yard manure, 4 tons on wheat only	115.92	3.73	118.37	5.81	158.25	10.68	157.75	11 83	17
18	Yard manure, 8 tons on wheat only	135.25	26.44	139 51	52.56	162.71	17.21	162.21	19.09	18
19	None	105.42	.....	101.33	.....	145.64	.....	143 00	.....	19
20	Acid phosphate, 160; muriate potash, 100. nitrate soda, 80	165.71	59.00	191.15	83.00	188 73	42.26	189 25	44.34	20
21	Same elements as 20, but nitrogen in oilmeal	167.50	59.50	189.74	74.78	180 46	33.14	181.74	34.93	21
22	None	109.29	.....	121.78	.....	148.15	.....	148.73	.....	22
23	Same elements as 20; but nitrogen in dried blood	159.25	46.58	174.74	51.60	175.71	27.76	181.93	34 06	23
24	Same elements as 20, but nitrogen in sulphate ammonia	175.17	59.13	182.29	57.78	182.99	35.31	181 60	34.58	24
25	None	119.42	.....	125.87	.....	147.55	.....	146.16	.....	25
26	Same elements as 11, but phosphorus in bonemeal	166.17	49.22	183.41	58.35	176,48	28.31	176 03	28.18	26
27	Same elements as 11, but phosphorus in dissolved boneblack	166.92	52.45	189.87	65.61	182 98	34.18	185.76	36.19	27
28	None	112.00	.....	123.45	.....	149.42	.....	151.25	.....	28
29	Same elements as 11, but phosphorus in basic slag	167.83	42.50	179.68	46.15	180.87	29.22	184.84	30.56	29
30	Yard manure, 8 tons on potatoes only	182.46	43.79	208.70	65.09	193.23	39.31	200.00	42.69	30
31	None	152.00	.....	153.69	.....	156.16	.....	160.34	.....	31
32	Yard manure, 16 tons on wheat only	191.42	43 17	195.47	47.86	180 09	37.12	195.00	44.43	32
33	Same elements (since 1899) as 20, but nitrogen in tankage	177.42	32.92	173.60	32 06	173.13	33.13	185.42	34.19	33
34	None	140.75	.....	135.46	.....	138.97	.....	144.96	..	34
	Average unfertilized yield	127.64		126.75		154 55		154.74		

TABLE XII. YIELD AND INCREASE OF *POTATOES* IN POTATOES-WHEAT-CLOVER ROTATION BY 6-YEAR PERIODS.

Plot	Fertilizing materials	Actual yield and increase				Corrected yield and increase				Plot
		1894-1899		1900-1905		1894-1899		1900-1905		
		Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
No.	Pounds per acre	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus,	No.
1	None	157.57	.....	180.49	.....	157.88	.....	190.92	.....	1
2	Acid phosphate, 160	178.25	18.77	202.33	18.02	178.68	18.10	209.57	18.43	2
3	Muriate potash 100	170.30	8.90	191.26	3.13	172.79	9.51	204.33	12.98	3
4	None	163.31	.....	191.95	.....	165.98	.....	191.57	.....	4
5	Nitrate soda, 80	167.64	6.17	191.46	6.93	171.15	8.30	195.62	10.59	5
6	Acid phosphate, 160; nitrate soda, 80	185.17	25.45	193.53	16.42	188.25	28.53	200.06	21.58	6
7	None	157.91	.....	169.68	.....	156.59	.....	171 94	.....	7
8	Acid phosphate, 160; muriate potash, 100	183.30	24.55	190.43	18.41	180 62	23.23	204.33	29.76	8
9	Muriate potash, 100; nitrate soda, 80	175.83	16.28	167.81	-6.54	173.73	15.54	179.35	2.15	9
10	None	160.42	.....	176.68	.....	158.99	.....	179.84	.....	10
11	Acid phosphate, 160, muriate potash, 100; nitrate soda, 80	177.17	18 32	193.65	15.85	175.89	18.44	197.64	18.30	11
12	Acid phosphate, 160; muriate potash, 100; nitrate soda, 160	186.09	28.81	198.19	19.27	182 42	27.63	202.57	23.73	12
13	None	155.70	.....	180.03	.....	154 38	.....	178.35	.....	13
14	Acid phosphate, 320; muriate potash, 200; nitrate soda, 160	183.34	27.37	197.42	24.61	186.01	30.61	208.65	35.99	14
15	Acid phosphate, 480; muriate potash, 300; nitrate soda, 320	193.61	37.38	181.12	15.52	191.98	37.79	196.94	30.48	15
16	None	156.49	.....	158.39	.....	154.09	.....	160.27	.....	16
17	Yard manure, 4 tons on wheat only	*180.22	*12.03	167.97	11.33	155.39	* 8.22	170.31	12.99	17
18	Yard manure, 8 tons on wheat only	*182.34	*13.10	173.42	18.53	154.69	*13.61	175.00	20.62	18
19	None	155.43	.....	153.13	.....	151.20	.....	151.43	.....	19
20	Acid phosphate, 160; muriate potash, 100; nitrate soda, 80	188.97	33.03	193.64	41.14	184.72	32.04	194.95	43.01	20
21	Same elements as 20, but nitrogen in oilmeal	182.89	26.44	180.88	28.35	178.56	24.42	184.70	32.26	21
22	None	159.96	.....	152.23	.....	155.62	.....	152.94	.....	22
23	Same elements as 20, but nitrogen in dried blood	181.55	27.93	170.84	15.89	178.22	25.39	187.20	33.56	23
24	Same elements as 20, but nitrogen in sulphate ammonia	176.03	25.75	189.87	32.52	175 62	25.56	185.61	31.27	24
25	None	146.94	.....	159.91	.....	147 28	.....	155.03	.....	25
26	Same elements as 11, but phosphorus in bonemeal	164.02	14.37	182.55	25.55	167.45	16.18	175.12	21.87	26
27	Same elements as 11, but phosphorus in dissolved boneblack	170.93	18.57	190.98	36.88	174.68	19.39	190.34	38.86	27
28	None	155.08	.....	151.20	.....	159.24	.....	149.70	.....	28
29	Same elements as 11, but phosphorus in basic slag	169.69	15.89	177 63	22.64	171.94	14.43	183.29	26.84	29
30	Yard manure, 8 tons on potatoes only	179.25	26.73	197.62	38.84	185.33	25.55	204.10	40.91	30
31	None	151.24	.....	162.58	.....	154.04	.....	169.94	.....	31
32	Yard manure, 16 tons on wheat only	*177.51	*15.45	199.63	38.70	*167.83	*16.47	200.18	38.02	32
33	Same elements (since 1899) as 20, but nitrogen in tankage	†167.31	†17.25	194.50	35.21	†166.69	†13.31	195.48	41.12	33
34	None	†145.55	.....	157.64	.....	†148.87	.....	146.58	.....	34
	Average unfertilized yield	154.74	.....	165.81	.....	154.63	.....	166.54	.....	

* Three years. † Five years

TABLE XIII. YIELD AND INCREASE PER ACRE OF *WHEAT* IN POTATOES-WHEAT-CLOVER ROTATION, 1908 AND 14 YEARS, 1895-1908.

Plot	Fertilizing materials	1908				14 years, 1894-1908				Plot
		Yield		Increase		Yield		Increase		
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	
No.	Pounds per acre	Bus.	Lbs.	Bus.	Lbs.	Bus.	Lbs.	Bus.	Lbs.	No.
1	None	41.92	4,165	.....	.....	30.91	3,142	.....	.....	1
2	Acid phosphate, 160	51.67	5,130	9.90	983	36.35	3,743	5 60	657	2
3	Muriate potash, 100	45.46	4,072	3.35	—38	32.68	3,005	2.05	-24	3
4	None	42.46	4,092	.....	.....	30.50	2,973	.....	.....	4
5	Nitrate soda, 160	39.08	4,035	—.92	249	30.73	3,200	.92	298	5
6	Acid phosphate, 160; dried blood, 50; nitrate soda, 120	46.21	4,697	8.67	1,216	36.42	3,814	7.31	983	6
7	None	35.08	3,175	.....	.....	28.41	2,759	.....	.....	7
8	Acid phosphate, 160; muriate potash, 100	47.17	4,150	10.49	824	36.06	3,350	7.26	596	8
9	Muriate potash, 100; dried blood, 50; nitrate soda, 120	39.67	3,770	1.40	294	34.45	3,216	5.27	468	9
10	None	39.87	3,627	.....	.....	29.57	2,742	.....	.....	10
11	Acid phos., 160; mur. potash, 100; dried blood, 50; nit. soda, 120	50.42	4,765	11.15	1,164	38.61	3,720	9.29	1,003	11
12	Acid phos., 160; mur. potash, 100; dried blood, 50: nit. soda, 200	48.08	4,645	9.40	1,069	38.38	3,853	9.31	1,161	12
13	None	38.08	3,550	.....	.....	28.81	2,666	.....	.....	13
14	Acid phos., 320; mur. potash, 200. dried blood, 50; nit. soda, 120	47.67	4,890	10.41	1,529	38.28	3,802	10.00	1,208	14
15	Fertilized on potatoes only	48.50	4,270	12.06	1,099	36.79	3,516	9.05	995	15
16	None	35.62	2,982	.....	.....	27.21	2,449	.....	.....	16
17	Yard manure, 4 tons	45.21	4,427	10.30	1,396	31.33	3,051	5 03	624	17
18	Yard manure, 8 tons	48.67	4,680	14.46	1,599	32.51	3,128	7.13	724	18
19	None	33.50	3,130	.....	.....	24.46	2,382	.....	.....	19
20	Acid phos., 160; mur. potash, 100; dried blood, 25; nit. soda, 60	49.83	4,510	17.33	1,627	33.96	3,295	9.62	982	20
21	Same elements as 20, but nitrogen in oilmeal	45.67	3,920	14.17	1,283	34.12	3,198	9.90	949	21
22	None	30.50	2,390	.....	.....	24.10	2,183	.....	.....	22
23	Same elements as 20, but nitrogen in dried blood	45.25	3,485	14.07	959	34.88	3,221	10.57	1,008	23
24	Same elements as 20, but nitrogen in sulphate ammonia	48.71	3,957	16.85	1,296	34.84	3,192	10.32	947	24
25	None	32.54	2,797	.....	.....	24.73	2,274	.....	.....	25
26	Same elements as 11, but phosphorus in bonemeal	47.04	4,127	15.18	1,309	35.64	3,351	10.85	1,025	26
27	Same elements as 11, but phosphorus in dissolved boneblack	49.17	4,390	17.99	1,551	36.95	3,631	12.12	1,253	27
28	None	30.50	2,860	.....	.....	24.88	2,429	.....	.....	28
29	Same elements as 11, but phosphorus in basic slag	48.67	4,580	17.88	1,468	37.61	3,736	12.75	1,315	29
30	Manured on potatoes	44.37	3,967	13.29	1,002	31.85	3,087	7.02	674	30
31	None	31.37	3,017	.....	.....	24.81	2,405	.....	.....	31
32	Yard manure, 16 tons	49.50	4,660	17.99	1,758	38.80	3,849	11.18	1,213	32
33	Same elements as 20, but nitrogen in tankage	47.58	3,765	15.93	978	38.75	3,570	11.48	1,009	33
34	None	31.79	2,672	.....	.....	26.93	2,486	.....	.....	34
	Average unfertilized yield	35 27	3,331			26.53	2 542			

TABLE XIV. YIELD AND INCREASE PER ACRE OF *WHEAT* IN POTATOES-WHEAT-CLOVER ROTATION BY PERIODS.

Plot	Fertilizing materials	1895-1900				1901-1906				Plot
		Grain		Straw		Grain		Straw		
		Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
No.	Pounds per acre	Bus.	Bus.	Lbs.	Lbs.	Bus.	Bus.	Lbs.	Lbs.	No.
1	None	24.24	.....	2,585	.....	34.72	.....	3,543	.....	1
2	Acid phosphate, 160	27.95	3.78	2,889	356	41.64	7.25	4,365	935	2
3	Muriate potash, 100	26.90	2.84	2,546	55	35.73	1.66	3,261	—56	3
4	None	23.96	.....	2,429	.....	33.75	.....	3,204	.....	4
5	Nitrate soda, 160	25.72	1.68	2,740	323	33.21	.66	3,440	298	5
6	Acid phosphate, 160; dried blood, 50; nitrate soda, 120	30.50	6.37	3,135	730	39.67	7.93	4,261	1,179	6
7	None	24.21	.....	2,392	.....	30.73	.....	3,021	.....	7
8	Acid phosphate, 160; muriate potash, 100	31.07	6.64	2,870	500	39.11	8.10	3,670	692	8
9	Muriate potash, 100; dried blood, 50: nitrate of soda, 120	30.57	5.90	2,737	389	36.60	5.30	3,464	529	9
10	None	24.90	.....	2,326	.....	31.58	.....	2,893	.....	10
11	Acid phos., 160; mur. potash, 100, dried blood, 50, nit. soda, 120	32.60	7.67	3,075	752	41.97	10.81	4,047	1,169	11
12	Acid phos., 160: mur. potash, 100; dried blood, 50, nit. soda, 200	33.36	8.40	3,205	886	40 94	10.21	4,145	1,283	12
13	None	24.98	.....	2,316	.....	30.30	.....	2,847	.....	13
14	Acid phos., 320: mur. potash, 200; dried blood, 50, nit. soda, 120	34.55	9.83	3,285	987	40.07	10.67	4,036	1,323	14
15	Fertilized on potatoes only	33.01	8.60	3,053	773	38.92	10.42	3,886	1,308	15
16	None	24.13	.....	2,260	.....	27.60	.....	2,444	.....	16
17	Yard manure, 4 tons	25.93	2.84	2,454	296	33.24	6.48	3,301	826	17
18	Yard manure, 8 tons	26.32	4.27	2,479	423	34.55	8.63	3,307	802	18
19	None	21.00	.....	1,954	.....	25.07	.....	2,536	.....	19
20	Acid phos., 160; mur. potash, 100; dried blood, 25. nit. soda, 60	26.25	5.34	2,483	558	37.98	12.92	3,676	1,234	20
21	Same elements as 20, but nitrogen in oilmeal	28.95	8.13	2,636	741	36.74	11.67	3,534	1,191	21
22	None	20.72	.....	1,865	.....	25.06	.....	2,251	.....	22
23	Same elements as 20, but nitrogen in dried blood	29.46	8.70	2,734	852	37.87	12.47	3,559	1,276	23
24	Same elements as 20, but nitrogen in sulphate ammonia	29.72	8.92	2,753	838	36.82	11.09	3,418	1,097	24
25	None	20.84	.....	1,918	.....	26.06	.....	2,515	.....	25
26	Same elements as 11, but phosphorus in bonemeal	30.41	9.33	2,915	953	38.16	12.21	3,485	1,075	26
27	Same elements as 11, but phosphorus in dissolved boneblack	31.23	9.92	2,981	974	39.74	13.89	3,999	1,535	27
28	None	21.55	.....	2,052	.....	25.73	.....	2,518	.....	28
29	Same elements as 11, but phosphorus in basic slag	32.23	10.80	3,094	1,062	39.91	14.21	4,074	1,535	29
30	Manured on potatoes	25.78	4.47	2,348	335	34.91	9.22	3,501	941	30
31	None	21.18	....	1,994	.....	25.66	.....	2,580	.....	31
32	Yard manure, 16 tons	37.73	9.89	3,556	976	37.39	11.74	3,812	1,291	32
33	Same elements as 20, but nitrogen in tankage	37.83	10.95	3,377	905	37.62	11.99	3,594	1,133	33
34	None	25.92	.....	2,357	.....	25.63	.....	2,402	.....	34
	Average unfertilized yield	22.62		2 158		28.49		2 716		

TABLE XV. YIELD AND INCREASE PER ACRE OF *CLOVER* IN POTATOES-WHEAT-CLOVER ROTATION, 1908, 13 YEARS, 1896-1908, AND BY 6-YEAR PERIODS.

Plot	Total fertilizing materials applied to previous crops of rotation. None on clover.	1908		13 years, 1896-1908		6 years, 1896-1901		6 years, 1902-1907		Plot
		Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
No.	Pounds per acre	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	No.
1	None	2,889	.....	4,151	.....	4,183	.....	4 335	.....	1
2	Acid phosphate, 320	3,653	667	4,341	346	4,412	348	4,398	291	2
3	Muriate potash, 200	3,431	342	3,906	64	4,051	107	3,865	18	3
4	None	3,191	.....	3,688	.....	3,824	.....	3,654	.....	4
5	Nitrate soda, 200; dried blood, 50	3,849	415	3,921	222	4,019	149	3,851	251	5
6	Acid phosphate, 320; nitrate soda, 200; dried blood, 50	4,667	990	4,053	343	4,041	126	3,960	417	6
7	None	3,920	.....	3,720	.....	3,960	.....	3,486	.....	7
8	Acid phosphate, 320; muriate potash, 200	3,787	166	3,904	229	4,116	151	3,748	304	8
9	Muriate potash, 200; nitrate soda, 200; dried blood, 50	4,676	1,355	4,148	518	4,248	280	3,976	574	9
10	None	3,022	.....	3,586	.....	3,972	.....	3,359	.....	10
11	Acid phos., 320; mur. potash, 200; nit. soda, 200; dried blood, 50	4,889	1,651	3,957	330	3,888	—79	3,859	451	11
12	Acid phos., 320; mur. potash, 200; nit. soda, 360; dried blood, 50	4,871	1,416	4,142	476	4,109	147	4,047	591	12
13	None	3,671	.....	3,706	.....	3,957	.....	3,502	.....	13
14	Acid phos., 480; mur. potash, 300; nit. soda, 280; dried blood, 50	5,049	1,402	4,129	498	3,874	18	4,187	746	14
15	Acid phos., 480; mur. potash, 300: nitrate soda, 320	5,307	1,683	4,135	579	4,062	306	4,001	630	15
16	None	3,600	.....	3,481	.....	3,656	.....	3,316	.....	16
17	Yard manure, 4 tons on wheat	4,782	1,398	4,026	635	4,011	397	3,913	691	17
18	Yard manure, 8 tons on wheat	5,200	2,033	4,345	1,045	4,401	829	4,155	1,059	18
19	None	2,951	.....	3,210	.....	3,530	.....	2,986	.....	19
20	Acid phos., 320; mur. potash, 200; nit. soda, 140, dried blood, 25	4,480	1,431	3,952	714	4,163	630	3,689	664	20
21	Same elements as 20, but nitrogen in oilmeal	4,907	1,761	3,612	346	3,826	292	3,218	155	21
22	None	3,244	.....	3,294	.....	3,537	.....	3,101	.....	22
23	Same elements as 20, but nitrogen in dried blood	4,560	1,408	3,637	334	3,412	—74	3,671	495	23
24	Same elements as 20, but nitrogen in sulphate ammonia	4,738	1,677	3,630	318	3,437	1	3,607	356	24
25	None	2,969	.....	3,321	.....	3,385	.....	3,326	.....	25
26	Same elements as 11, but phosphorus in bonemeal	5,031	1,807	3,951	591	3,628	213	4,039	702	26
27	Same elements as 11, but phosphorus in dissolved boneblack	4,658	1,180	3,758	361	3,506	63	3,817	472	27
28	None	3,733	.....	3,435	.....	3,474	.....	3,355	.....	28
29	Same elements as 11, but phosphorus in basic slag	5,022	1,478	4,197	805	4,175	756	4,078	740	29
30	Yard manure, 8 tons on potatoes	4,764	1 411	4,178	829	3,983	619	4,242	905	30
31	None	3,164	.....	3,306	.....	3,309	.....	3,328	.....	31
32	Yard manure, 16 tons on wheat	5,644	2,877	3,933	1,211	3,891	742	4,979	1,573	32
33	Same elements as 20, but nitrogen in tankage	4,471	2,101	3,137	413	3,378	241	3,840	355	33
34	None	1,973	.....	2,727	.. ..	3,125	....	3,564	. ...	34
	Average unfertilized yield	3 194		3 526		3 692		3 443		

BARNYARD MANURE TEST.

COMPARISON OF YARD WITH FRESH MANURE.

THE REINFORCEMENT OF MANURE.

This experiment was begun in 1897 for the purpose of comparing manure which has lain for some months in an open barnyard with that taken directly from the stable to the field, and of studying the effect of treating the manure with several absorbent or reinforcing materials.

In this investigation a lot of manure has been taken from the open barnyard, where it has been accumulating during the winter and divided into four parcels. With one parcel is mixed the finely ground, phosphatic rock, known as floats, from which acid phosphate is made by mixing it with sulphuric acid; with another parcel acid phosphate is mixed; with a third, the crude potash salt, known as kainit, and with a fourth, land plaster or gypsum; the reinforcing materials being used at the uniform rate of 40 pounds per ton of manure. At the same time manure taken from box stalls, where it has accumulated under the feet of animals kept continuously in their stalls, is divided into similar parcels and treated with like quantities of the same materials.

After a few weeks the manure thus treated, together with two lots of untreated manure, one taken from the yard and one from the stable, is spread upon clover sod at the rate of eight tons per acre and plowed under for corn, the corn being followed by wheat and clover in a 3-year rotation. During the first three seasons Soy beans were grown, because of clover failure, and were plowed under.

Three tracts of land, A, B and C, are included in the test, each crop being grown every season. The arrangement of these tracts and the plan of fertilizing are shown in Diagram V.

DIAGRAM IV: ARRANGEMENT OF PLOTS AND PLAN OF FERTILIZING IN EXPERIMENTS WITH MANURE

PLOTS ONE-SIXTEENTH ACRE

11	Nothing	Nothing	1
12	Yard manure and gypsum	Yard manure and floats	2
13	Stall manure and gypsum	Stall manure and floats	3
14	Nothing	Nothing	4
15	Yard manure, untreated	Yard manure and acid phos.	5
16	Stall manure, untreated	Stall manure ahd acid phos.	6
17	Nothing	Nothing	7
18	Chemical fertilizer	Yard manure and kainit	8
19	Chemical fertilizer	Stall manure and kainit	9
20	Nothing	Nothing	10

SECTION A

11	Nothing	Nothing	1
12	Yard manure and gypsum	Yard manure and floats	2
13	Stall manure and gypsum	Stall manure and floats	3
14	Nothing	Nothing	4
15	Yard manure, untreated	Yard manure and acid phos.	5
16	Stall manure, untreated	Stall manure and acid phos.	6
17	Nothing	Nothing	7
18	Chemical fertilizer	Yard manure and kainit	8
19	Chemical fertilizer	Stall manure and kainit	9
20	Nothing	Nothing	10

SECTION B

11	Nothing	Nothing	1
12	Yard manure and gypsum	Yard manure and floats	2
13	Stall manure and gypsum	Stall manure and floats	3
14	Nothing	Nothing	4
15	Yard manure, untreated	Yard manure and acid phos.	5
16	Stall manure, untreated	Stall manure and acid phos.	6
17	Nothing	Nothing	7
18	Chemical fertilizer	Yard manure and kainit	8
19	Chemical fertilizer	Stall manure and kainit	9
20	Nothing	Nothing	10

SECTION C

NORTH

TABLE XVI. BARNYARD MANURE ON CROPS GROWN IN 3-YEAR ROTATION. AVERAGE YIELD PER ACRE 1908, AND 12 YEARS 1897-1908.

Plot No.	Manure and treatment	1908					12 years, 1897-1908					Plot No.
		Corn, Section B		Wheat, Section C		Hay	Corn		Wheat 11 years		Hay 8 years	
		Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	Lbs.	Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	Lbs.	
		Yield per acre.										
1	None	28.11	1,840	18.67	2,000	2,435	37.15	2,222	12.14	1,477	2,372	1
2	Yard manure and floats	65.88	3,280	33.20	3,384	4,711	59.42	3,313	25.03	2,696	3,791	2
3	Stall manure and floats	66.86	2,992	32.47	3,476	5,066	63.31	3,565	26.42	2,887	4,389	3
4	None	26.97	2,000	11.47	1,552	1,902	31.03	2,009	10.35	1,226	1,787	4
5	Yard manure and acid phosphate	67.03	3,264	32.20	3,716	4,391	60.27	3,276	25.33	2,716	3,543	5
6	Stall manure and acid phosphate	63.09	2,784	32.47	3,588	5,242	64.38	3,471	26.18	2,871	4,341	6
7	None	23.14	1,680	11.93	1,572	1,475	30.83	1,970	9.67	1,157	1,696	7
8	Yard manure and kainit	59.71	3,120	25.67	3,036	3,413	54.63	3,154	21.31	2,394	2,984	8
9	Stall manure and kainit	59.77	2,944	27.20	3,136	5,102	60.07	3,495	23.35	2,701	3,885	9
10	None	36.00	1,968	8.87	1,164	1,137	32.89	2,003	10.29	1,208	1,906	10
11	None	28.84	1,728	18.53	2,296	1,955	36.83	2,333	13.07	1,616	2,593	11
12	Yard manure and gypsum	60.51	2,784	29.07	3,472	3,413	57.98	3,364	23.44	2,645	3,268	12
13	Stall manure and gypsum	61.71	2,624	27.07	3,048	4,160	60.66	3,550	23.27	2,619	3,295	13
14	None	21.43	1,712	12.40	1,464	1,902	31 57	2,007	9.86	1,137	1,698	14
15	Yard manure, untreated	57.31	2,640	24.40	2,536	3,537	51.17	2,886	18.76	2,113	2,550	15
16	Stall manure, untreated	57.83	2,576	26.60	2,724	4,675	58.16	3,304	20.35	2,281	3,269	16
17	None	38.80	2,176	13.07	1,536	2,061	36.55	2,303	10.21	1,239	1,991	17
18	Chemical fertilizer*	49.43	2,688	20.67	2,104	2,844	43.12	2,587	13.42	1,562	2,717	18
19	Chemical fertilizer†	56.34	2,592	20.13	2,056	2,986	44.37	2,456	14.91	1,762	2,860	19
20	None	33.49	1,920	9.07	1,232	2,066	34.09	2,025	9.98	1,248	2,197	20
	Average unmanured yield	29.53	1,878	13.00	1,602	1,867	33.87	2,108	10.67	1,991	1,255	

* Acid phosphate, 80 lbs., muriate potash, 80 lbs., nitrate soda, 160 lbs. †Acid phosphate, 80 lbs., muriate potash, 10 lbs., tankage (7-30) 100 lbs.

The table shows that in 1908 the difference in effect between the yard and stall manure and between the two phosphates was smaller than the average, but this has usually been the case when corn and wheat were grown on these two sections.

TABLE XVII. BARNYARD MANURE ON CROPS GROWN IN 3-YEAR ROTATION. INCREASE PER ACRE 12 YEARS, 1897-1908.

Plot No.	Manure and treatment	12 years, 1897-1908				
		Corn		Wheat		Hay
		Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	Lbs.
		Increase per acre.				
2	Yard manure and floats	24.31	1,162	13.49	1,302	1,614
3	Stall manure and floats	30.24	1,485	15.48	1,577	2,407
5	Yard manure and acid phosphate	29.30	1,280	15.21	1,513	1,786
6	Stall manure and acid phosphate	33.48	1,487	16.29	1,692	2,614
8	Yard manure and kainit	23.11	1,172	11 43	1,220	1,217
9	Stall manure and kainit	27.86	1,503	13.27	1,510	2,048
12	Yard manure and gypsum	22.90	1,139	11.45	1,189	973
13	Stall manure and gypsum	27.34	1,434	12.34	1,323	1,299
15	Yard manure, untreated	17.94	781	8.78	942	754
16	Stall manure, untreated	23.27	1,101	10.26	1,076	1,376
18	Chemical fertilizer*	7.39	377	3.28	320	657
19	Chemical fertilizer†	9.46	337	4.85	517	731

TABLE XVIII. BARNYARD MANURE ON CROPS GROWN IN 3-YEAR ROTATION. AVERAGE VALUES OF TOTAL YIELD AND OF INCREASE.

Plot No.	Manure and treatment	Cost of treatment	Value of total yield per acre		Value of increase		
			Total	Net	Total per acre	Net per acre	Net per ton manure
2	Yard manure and floats	$1.40	$66.62	$65.22	$30.02	$28.62	$3.58
3	Stall manure and floats	1.40	72.25	70.85	37.91	36.51	4.56
5	Yard manure and acid phosphate	2.40	66 17	63 77	34.46	32 06	4.01
6	Stall manure and acid phosphate	2.40	72.14	69.74	40.80	38.40	4 80
8	Yard manure and kainit	2.70	57.96	55.26	26.23	23.53	2.94
9	Stall manure and kainit	2.70	66.19	63.49	33.72	31.02	3.88
12	Yard manure and gypsum	1.00	62 71	61.71	25.11	24.11	3.01
13	Stall manure and gypsum	1.00	64.00	63.00	29.48	28.48	3.56
15	Yard manure, untreated	....	52.12	52.12	19.33	19.33	2 42
16	Stall manure, untreated	....	59.36	59.86	25.75	25.75	3.22

The financial outcome of this test is shown in Table XVIII, in which the materials used in treatment are re-valued in accordance with present prices.

It will be observed that the average increase produced by the ton of stall manure has in every case been greater than that from the ton of yard manure similarly treated, and that the ton of stall manure treated with acid phosphate has produced nearly double the increase recovered from the ton of untreated yard manure.

While the treatment of manure has in every case increased its effectiveness, the gain per acre produced by reinforcing the manure with acid phosphate has apparently been so much greater than that from any other treatment that it has not been profitable to use anything else, even though the other materials had cost nothing.

It is true that the average total yield of the two plots receiving manure treated with floats has been so nearly the same as that of the plots dressed with manure treated with acid phosphate, that when the difference in cost of the reenforcing materials is taken into consideration the net totals following the floats treatment are slightly greater than those following the acid phosphate, the apparently greater increase on the acid phosphate plots being due to the relatively large yields of the unmanured plots, 1 and 11; but a careful study of the land on which this test is located leads us to believe that the variation in yield between these plots and the next unmanured plots, 4 and 14, is due to a progressive variation in the soil, and that the true method of comparison is the one which we have followed.

In Table XIX the results of this test are arranged in periods, as has been done in the experiments reported in the preceding pages, in order to show the cumulative effect of the fertilizers and manures.

TABLE XIX. BARNYARD MANURE ON CROPS GROWN IN ROTATION. YIELD AND INCREASE PER ACRE BY PERIODS.

Plot No.	Manure and treatment	First period					Second period					Plot No.
		Corn, 1897-1902		Wheat, 1898-1903		Hay 1901 1904	Corn, 1903-1908		Wheat, 1904-1908		Hay 1905-1908	
		Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	Lbs.	Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	Lbs.	
	Yield per acre.											
1	None	41.63	1,983	9.74	1,050	2,072	32.68	2,461	15 02	1,990	2,672	1
2	Yard manure and floats	60.22	2,957	22.39	2,195	3,416	58.61	3,669	28.20	3,297	4,167	2
3	Stall manure and floats	62.68	3,114	24.28	2,431	3,908	63 95	4,016	29.00	3,434	4,871	3
4	None	37.77	1,909	8.45	845	1,604	24 30	2,109	12 63	1,583	1,971	4
5	Yard manure and acid phosphate	61.46	2,908	21.50	2,075	3,028	59 08	3,644	29 93	3,484	4,059	5
6	Stall manure and acid phosphate	63.46	3,127	23.37	2,336	3,804	65 30	3,814	29 55	3,514	4,878	6
7	None	37.66	1,797	7 19	768	1,315	22.51	2,143	12.64	1,622	2,077	7
8	Yard manure and kainit	58 99	2,918	18.50	1,836	2,362	50.26	3,389	24 68	3,063	3,605	8
9	Stall manure and kainit	61 05	3,105	20 99	2,167	3,092	59.08	3,885	26.19	3,341	4,678	9
10	None	41.54	2,020	8.41	823	1,560	24 24	1,987	12 55	1,670	2,251	10
11	None	41.00	2,228	11.05	1,136	2,276	32 67	2,439	15 49	2,191	2,911	11
12	Yard manure and gypsum	60 88	3,024	21.90	2,164	2,880	55.08	3,703	25.30	3,222	3,657	12
13	Stall manure and gypsum	63.50	3,270	22 54	2,223	2,692	57.83	3,829	24.15	3,095	3,899	13
14	None	39 03	1,895	7.43	786	1,406	24 11	2,118	12.79	1,559	1,990	14
15	Yard manure, untreated	55 00	2,666	15.63	1,579	1,952	47.36	3,107	22.52	2,754	3,148	15
16	Stall manure, untreated	59 20	2,966	17.59	1,803	2,496	57.11	3,643	23.67	2,855	4,043	16
17	None	40 71	2,006	7.85	875	1,824	32.39	2,600	13.04	1,675	2,159	17
18	Chemical fertilizer*	47 96	2,358	10.46	1,087	2,168	38.27	2,816	16.99	2,133	3,266	18
19	Chemical fertilizer†	49.47	2,342	11 88	1,196	2,344	39.27	2,670	18.54	2,441	3,376	19
20	None	41.48	2,007	7 93	898	1,768	26.70	2,043	12.46	1,669	2,627	20
	Average unmanured yield	40.10	1,979	8.51	898	1,678	27.63	2,237	13.26	1,683	2,305	
	Increase per acre.											
2	Yard manure and floats	19.88	998	13 08	1,214	1,500	28.75	1,326	13.98	1,409	1,729	2
3	Stall manure and floats	23.62	1,181	15.39	1,518	2,148	36.86	1,790	15.58	1,649	2,667	3
5	Yard manure and acid phosphate	23.72	1,037	13.46	1,256	1,520	34.88	1,523	17.30	1,821	2,503	5
6	Stall manure and acid phosphate	25 76	1,293	15.76	1,543	2,392	41.19	1,682	17.43	1,873	2,836	6
8	Yard manure and kainit	20.03	1,046	10 90	1,050	966	26.18	1,298	12.07	1,425	1,469	8
9	Stall manure and kainit	20.81	1,159	12.99	1,362	1 613	34.91	1,847	13.61	1,687	2,484	9
12	Yard manure and gypsum	20 53	907	12.06	1,145	894	25.27	1,371	10.72	1,242	1,053	12
13	Stall manure and gypsum	23 80	1,264	13.90	1,320	996	30 87	1,604	10 46	1,326	1,601	13
15	Yard manure, untreated	15 39	754	8.06	764	406	20.50	828	9 65	1,157	1,102	15
16	Stall manure, untreated	19.04	997	9.88	958	811	27.49	1,204	10.71	1 218	1,941	16
18	Chemical fertilizer*	6.99	351	2.58	204	363	7.78	402	4.13	460	951	18
19	Chemical fertilizer†	8.99	335	3.98	306	557	10.68	339	5.89	770	903	19

* Acid phosphate, 80 lbs., muriate potash, 80 lbs.; nitrate soda, 160 lbs. † Acid phosphate, 70 lbs., muriate potash, 100 lbs., tankage (7-30) 100 lbs.

An analysis of Table XIX brings out the following points: The unmanured yield of corn has fallen off during the second period, as compared with the first; the yields of all the plots dressed with yard manure are also smaller during the second period; the plots dressed with untreated stall manure, or with stall manure treated with gypsum or kainit, also give smaller yields during the second period, while those receiving stall manure reenforced with floats or acid phosphate show larger yields for the second period. The reduction in yield on the manured plots, however, is much less than on those receiving no manure, consequently the increase from the manures is invariably greater during the second period.

The wheat crop shows a general gain in yield on both manured and unmanured land during the second period, due in part, at least, to the fact that it suffered from an attack of Hessian fly and from more unfavorable winter conditions during the first period.

The increase of wheat from the untreated manure and from all the treatments, except with gypsum, is greater during the second period, but the rate of increase after acid phosphate is greater than that after floats or kainit.

The hay shows a larger increase on all the land during the second period, but this is partly due to the fact that the use of lime was begun during this period, the lime being applied to all the land, both manured and unmanured, other experiments having shown that the addition of lime to this soil is absolutely necessary before manure or fertilizers can produce their full effect.

SUMMARY.

In the case of the crops grown continuously on the same land there has been a rapid falling off in yield during recent years on the unfertilized land, whereas there has been a slight increase in yield on similar land when the same crops have been grown in rotation with each other and with clover. A given quantity of manure or fertilizer, moreover, has produced a smaller increase on crops grown continuously than on those grown in rotation.

In the 5-year rotation of corn, oats, wheat, clover and timothy, the unfertilized yield of corn has remained practically stationary throughout the 15 years of the test; that of oats has been slightly larger dnring the last five years than previously, and that of wheat decidedly larger, this gain in wheat yield being due chiefly to greater immunity to insect attack during the latter period. The average increase per acre in all the cereal crops has been very much greater during the latter period than formerly, due to the cumulative effect on the fertilizers and manure.

As between chemical fertilizers and open-yard manure, the manure has shown the greater increase in effectiveness during the later years of the test.

On both the thin land on which this 5-year test is located and on the richer soil used in the 3-year rotation of potatoes, wheat and clover the greatest total yield and the greatest net gain after deducting the cost of the fertilizer, have been produced by complete fertilizers, carrying nitrogen in nitrate of soda, phosphorus in acid phosphate and potassium in muriate of potash. The experiments, however, demonstrate the practicability of replacing the nitrogen and potassium with stable manure, thus greatly diminishing the cost of fertilizing and increasing the net gain.

The experiments with manure forcibly demonstrate the importance of avoiding the waste to which manure is subjected while lying in open barnyards and of reenforcing manure with some carrier of phosphorus, to replace the phosphorus carried away in the bones of live stock, in milk, and in the grains which are sold off the farm.

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